## 901-107 Fetal Model of Single Ventricle Physiology: Hemodynamic Effects of Epinephrine, Sodium Bicarbonate, and Calcium Chloride

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Neonatal and infant patients (pts) with single ventricle physiology (SVP) following bypass, for e.g. pts after stage I repair of hypoplastic left heart syndrome (HLHS), often suffer from hemodynamic instability early after surgery. Specific hemodynamic effects of pharmacologic resuscitation are poorly understood. To examine these issues a model of SVP was created in fetal lambs: a Damus procedure was performed in fetal lambs using a 10 mm ePTFE tube graft and the main pulmonary artery was ligated distally. Pulmonary blood flow (PBF) was provided by creating a 6 mm systemic to pulmonary artery shunt. Neonatal lambs with SVP were delivered normally at term. At 48 hours after birth the lambs (n = 10) were instrumented and monitored. Ultrasonic flow probes were placed on the aorta and the shunt to measure systemic blood flow (SBF) and PBF. Interventions were performed in random order before and after cardiopulmonary bypass and a 30 min period of hypothermic circulatory arrest to mimic the clinical setting e.g. stage I repair of HLHS. The effects on systemic and pulmonary vascular resistances (SVR and PVR), PBF, and SBF are shown below

| Intervention | PBF | SBF | PVR:SVR | PBF[1] | SBF[1] | PVR:SVR[1] |
|---|---|---|---|---|---|---|
| Epi infusion[2] | 13.5* | 20.8* | +6.8 | 13.8* | 14.5* | −7.5 |
| Bicarbonate[3] | 9.2* | 13.5* | −4.5 | 10.2* | 16.6* | −0.4 |
| Ca chloride[4] | 7.9* | 16.8* | +2.6 | 12.64* | 18.7* | −1.7 |
| Epi bolus[5] | | | | 94.1* | −68.8* | −88.8* |

*Values represent percent increase or decrease from baseline. 1: post bypass; 2: epinephrine 0.1 μg/kg/min; 3: sodium bicarbonate 2 mEq/kg 4: calcium chloride 10 mg/kg; 5: epinephrine 1 in 10,000: 0.05 ml/kg, * P < 0.05.*

In summary this is the first reported model which provides a useful tool to study neonatal SVP. Epinephrine infusion, sodium bicarbonate bolus, and calcium chloride bolus increased both PBF and SBF. Epinephrine bolus even at half the recommended code dose caused a tremendous increase in PBF and severe decrease in systemic blood flow causing metabolic acidosis. On average it took 5 min for the flows to return to base line values. This suggests that epinephrine boluses should be used judiciously and probably be considerably smaller in the management of patients with SVP. Calcium chloride had a good inotropic effect without significant effect on PVR:SVR ratio.

# PERIPHERAL VASCULAR DISEASE/THROMBOSIS/EMBOLISM — CLINICAL

## 901-108 Atheromatous Disease of the Thoracic Aorta: A Transesophageal Echocardiography and Autopsy Correlative Study

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Transesophageal echocardiography (TEE) is widely used for the evaluation of thoracic aortic pathology, most recently atheromatous disease. Unfortunately, there have not been any studies correlating TEE and autopsy findings of atheroma to validate this use of the technique. Also, the TEE grading systems for aortic atheromatous disease currently in use have not been established to parallel pathologic grading systems, nor has their clinical significance been tested.

We retrospectively evaluated all patients who underwent TEE at our institution between 1988 and 1993 and subsequently underwent autopsy within 30 days of the TEE study. We identified 13 patients with adequate thoracic aortic tissue available for pathologic analysis who also had a complete TEE examination of either the ascending, arch or descending thoracic aortic segments. Among these there were 21 complete tissue segments available which had been adequately imaged. All segments were reviewed and compared with respect to: (1) surface area and pattern of atheroma, (2) area and pattern of calcification, (3) depth of mural ulceration, and (4) type and description of mural thrombus; also (5) measurements of maximum wall thickness, (6) sizing of any aneurysm, and (7) characterization of any dissection.

Significant correlations were found using this detailed grading system for surface area of atheroma (kappa test, $\kappa = 0.29 \pm 0.26$), wall thickness (correlation, r = 0.56), correct identification of the one ascending aortic aneurysm, and absence of dissection or mural thrombus. The correlations for pattern of atheroma, area and pattern of calcification and depth of ulceration did not reach statistical significance. However, there was an 86 to 100% agreement for these lesion characteristics when allowing for 1 category of variation.

*Conclusions:* There is a good correlation between TEE and autopsy findings with respect to: (1) atheroma surface area, (2) aortic wall thickness, and (3) the identification of aortic aneurysm. TEE and autopsy grading of lesion characteristics have excellent agreement when allowing for one category of variation. The clinical relevance of this grading system requires further study.

## 901-109 Value of Visualizing Atherosclerotic Plaques on the Thoracic Aorta by Transesophageal Echocardiography in Conjunction with Pharmacologic Stress

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Detection of atherosclerotic plaques within the thoracic aorta (TA) by transesophageal echocardiography (TEE) has been shown to be a useful marker to detect coronary artery disease (CAD). Dobutamine (Dob) stress echocardiography can induce segmental wall motion abnormalities (SWMA) in the presence of CAD. To determine the value of visualizing atherosclerotic plaques on the TA in conjunction with Dob-TEE, 60 pts (54 males, 6 females; mean age 59 ± 13 yrs) with chest pain syndrome were studied. All pts underwent coronary angiography. Dob was infused in 3-min increments from 5 to 40 mcg/kg/min. Dob-TEE was considered positive if new or worsening of previously present SWMA were noted. Atherosclerotic plaques visualized on TA were divided into simple and complex lesions. Simple lesions were defined as intimal thickening or luminal irregularities, and complex lesions were protruding, ulcerated or mobile plaques noted. *Results:* Significant CAD (≥50% stenosis) was present in 49 pts and 11 pts had normal or non-significant disease. Sensitivity (SE), specificity (SP), positive (+PV), negative (−PV) predictive values, and diagnostic accuracy (DA) are:

| | SE | SP | +PV | −PV | DA |
|---|---|---|---|---|---|
| Dob-TEE | 94% | 73% | 94% | 73% | 90% |
| TA-TEE | 90% | 80% | 93% | 73% | 88% |

The TA showed atherosclerotic plaques in 45 of 49 pts with positive Dob-TEE and it was free of disease in 9 of 11 pts with negative Dob-TEE (90% agreement). The presence of complex lesions was significantly higher in pts with multivessel disease (MVD) (21 of 32 pts 66%) than in those with single vessel disease (SVD) (3 of 17 pts 18%), $p < 0.01$. While simple lesions were more common in SVD (11 of 17 pts 65%) than in MVD (9 of 32 pts 28%), $p < 0.01$. *In conclusion,* TA-TEE and Dob-TEE highly concur in detecting CAD. Visualization of complex lesions on TA-TEE *before* Dob-TEE should alert for the possibility of MVD.

## 901-110 Three-Dimensional Ultrasound Can Accurately Reconstruct Intravascular Thrombi: In Vitro Validation

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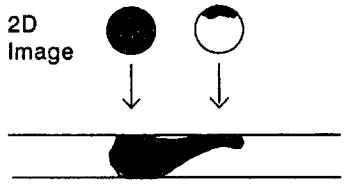
High-frequency ultrasound can potentially display gross morphologic changes during thrombus formation and lysis. Current intravascular ultrasound (IVUS) devices, however, provide only 2-dimensional cross-sectional images with limited overall appreciation of thrombus size and 3-dimensional (3D) configuration. The purpose of this study was to explore the ability of 3D reconstruction of serial ultrasound images to provide a quantitative assessment of intravascular thrombi. We therefore imaged 11 arterial thrombi of varying shape and volume (10 to 116 $mm^3$). To avoid thrombus disruption, we used an epivascular approach (also suitable for transvenous imaging) with a 20 MHz IVUS catheter withdrawn at 1 mm/sec. A 3D voxel image intensity data set was reconstructed, and thrombus volume was semiautomatically extracted based on its intensity. Calculated volume was compared with directly measured values by volume displacement in a miniature cylinder.




Longitudinal section of 3D reconstruction

*Results:* 3D reconstruction provided previously unobtainable longitudinal and 3D views that improved spatial appreciation of thrombus size, shape and channel formation. Calculated thrombus volumes agreed well with actual volumes: $y = 0.92x + 2.4$, r = 0.98, SEE = 5 $mm^3$, mean error = 1 ± 5 $mm^3$